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DEVICE AND METHOD FOR GROUPING, ORGANIZING AND SEPARATING  
MULTIPLE CABLES AND OTHER CONTROL LINES

Background

The installation and maintenance of industrial automation field devices typically requires multiple cables that are identical or very similar in appearance to be matched and mated with a select connector of an input/output (I/O) module or other device. Cable to connector mis-match can occur and results in one or more undesirable outcomes including failure of the field device (e.g., sensor or actuator) and/or I/O module, erroneous data transfer between the I/O module and field device, perceived failure of the one or more components. These undesirable outcomes and others increase machine down-time, labor costs to isolate and repair errors, parts cost and can contribute to unfavorable perception of the industrial automation system overall.

Known devices and methods for organizing cables and other control lines (e.g., electrical cables, hydraulic hoses, pneumatic hoses, etc.) are sub-optimal for overcoming the above-noted problems. One known approach

involves labeling each cable so that it is associated with a particular device connector. This approach is labor-intensive and requires that the technician make the correct cable-to-connector labeling and association. Also, multiple I/O modules are commonly mounted adjacent each other and a technician can easily mate a cable to a connector on the incorrect module.

Another known method involves use of wire loom separation devices. These devices are immovably secured to a support surface and hold the cables or other control lines in a select arrangement relative to each other.

Known wire loom separators have not been widely employed for use in connection with industrial automation field devices and other applications for a variety of reasons. One drawback associated with these devices is that they are immovable and, thus, do not facilitate movement of the cables or other control lines to a position where they will not interfere with the installation/replacement of a device such as an I/O module or other work being performed. Some wire loom separation devices require use of fasteners to secure the cables in position, and this is generally undesirable for a wide

variety of reasons including cost of manufacture, labor cost for assembly, lost parts, and the like.

For devices such as industrial automation I/O modules and the like, including multiple rows and columns of connectors, there is no known wire loom separation device that holds the cables or other control lines directly aligned with the respective connectors to which they are intended to be connected, i.e., with the cable-receiving locations of the wire loom separation device arranged and located in a pattern that corresponds directly in terms of location and spacing to the pattern of the connectors to which the cables are intended to be connected. Furthermore, there is no such device defined from a transparent polymeric material that allows for unobstructed viewing of the I/O module or other device (including its indicator lights and other visual output devices) to which the cables or other control lines are connected while still holding the cables or other control lines in the required connector pattern, with each control line aligned with a particular connector along a connection axis of the connector.

### **Summary**

In accordance with a first aspect of the present development, a device for holding a plurality of associated control lines in a defined orientation relative to each other is provided. The device includes a control line support structure that defines a plurality of control line receiving and retaining locations each adapted to receive and releasably retain an associated cable or other control line. A flexible retainer projects outwardly from the support structure and is adapted for movably securing the support structure to an associated mounting location.

In accordance with another aspect of the present development, a device for holding a plurality of associated control lines in a defined orientation relative to each other is provided. The device includes a control line support structure that defines a plurality of control line receiving and retaining locations each adapted to receive and releasably retain an associated cable or other control line. The support structure comprises a transparent polymeric sheet member.

In accordance with another aspect of the present development, device for holding a plurality of associated cables in a defined orientation relative to each other is

provided. The device comprises a support structure that defines a plurality of cable retaining locations each adapted to receive and releasably retain an associated cable. The cable retaining locations are arranged in a pattern that corresponds to a pattern of connectors of an associated input/output interface device to which the cables are adapted to be connected so as to provide a one-to-one correspondence between each cable retaining location and each connector of the associated input/output device.

#### **Brief Description of the Drawings**

The present development comprises various components and arrangements of components, and/or various steps and arrangements of steps, preferred embodiments of which are disclosed herein with reference to the accompanying drawings wherein:

FIG. 1 is a diagrammatic illustration of a modular control line interface assembly such as a modular input/output assembly for an industrial automation system;

FIG. 2A is a diagrammatic illustration of a control line interface device such as an input/output block of an industrial automation system mounted to a support structure;

FIG. 2B is a view taken along line B-B of FIG. 2A;

FIG. 3A illustrates a device for grouping, organizing and separating multiple cables and other control lines formed in accordance with the present development;

FIG. 3B is a view taken along line B-B of FIG. 3A;

FIG. 4 illustrates use of the device shown in FIGS. 3A and 3B;

FIG. 5A illustrates an embodiment of a device for grouping, organizing and separating multiple cables or other control lines formed in accordance with the present development;

FIG. 5B illustrates a device for grouping, organizing and separating multiple cables or other control lines formed in accordance with another embodiment;

FIG. 5C is a view taken along line C-C of FIG. 5B;

FIG. 5D is a view similar to FIG. 5C, but shows a cable or other control line in phantom lines and use of the device to hold same;

FIGS. 5E and 5F illustrate respective alternative embodiments of a device for grouping, organizing and separating multiple cables or other control lines formed in accordance with the present development;

FIG. 6A illustrates one example of an installation of a device formed in accordance with the present development;

FIG. 6B illustrates another example of an installation of a device formed in accordance with the present development;

FIG. 7 is similar to FIG. 2B but shows a device formed in accordance with the present invention connected to the support bracket structure and use of same to separate, hold and organize cables or other control lines (the control lines are shown in phantom);

FIG. 8 illustrates a device for grouping, organizing and separating multiple cables or other control lines formed in accordance with another alternative embodiment as installed for use in association with a rack-mounted control line interface device such as an ethernet switch;

FIG. 9A illustrates a support bracket structure for a control line interface device formed in accordance with another aspect of the development;

FIG. 9B is a view taken along line B-B of FIG. 9A.

### Detailed Description

FIG. 1 is a diagrammatic illustration of a modular control line interface assembly 10 such as the illustrated modular electronic input/output (I/O) assembly for an industrial automation system. The assembly comprises multiple releasably interconnected modules **M1 - M7**, each of which comprises a plurality of control line connectors **C** to which cables or other control lines are connected. Each module **M1 - M7** often comprises written or other indicia **I** to provide information and visual indicators such as light emitting diodes **LED** or the like.

When the control lines (not shown in FIG. 1) are mated to the connectors **C** of each module **M1 - M7**, the result is often a confusing collection of control lines, even when the control lines are tied together in bundles or the like. The confusion is compounded by the fact that the control lines are often identical or very similar in appearance. Individual or multiple modules **M1 - M7** or related components are sometimes serviced or replaced, and this requires that multiple control lines connected to multiple modules be disconnected and then reconnected to the same connector location when the modules are replaced. This operation (and other operations that require disconnection

of the control lines) requires that a technician carefully label or otherwise track each control line so that the control line can be reconnected to the exact connector location from which it was disconnected. This procedure is rendered more difficult owing to the lack of conventional connector arrangement/numbering schemes. As such, improper connections can be made and this result is highly undesirable as described above.

FIGS. 2A and 2B illustrate an individual control line interface assembly or block 110 such as, e.g., an input/output (I/O) connection block for an industrial automation system. The block 110 comprises plurality of control line connectors C1 - C8 to which cables or other control lines are respectively connected (not shown). The block 110 also comprises indicia (e.g., brand, model, etc.) I and visual indicators such as light emitting diodes LED. The block 110 is connected to a base structure or bracket S by fasteners or the like (not shown). The bracket S comprises a C-shaped cross-section (FIG. 2B) defined by a base wall S1 and first and second side walls S2, S3 so that the support bracket S defines an open recess S4 that houses the interface block 110.

In a typical application, multiple brackets **S**, each including a block **110** connected thereto, are connected to a machine or other mounting location adjacent to each other. Here, again, when one or more of the blocks **110** must be replaced or serviced or when the cables or other control lines must be disconnected for other reasons, there is a risk that the control lines will be connected to the incorrect connectors **C1 - C8** and/or incorrect blocks **110** upon "completion" of the service/replacement operation.

FIGS. 3A and 3B provide front and side elevational views of a device **100** for grouping, organizing and separating multiple cables and other control lines formed in accordance with the present development. The device comprises a control line support structure **20** that defines a plurality of control line receiving and retaining locations **30** such as locations **30a - 30h** as shown. Each control line receiving location **30a - 30h** is adapted to receive and releasably retain an associated electronic data cable or other control line **L** (only one shown), preferably while allowing axial sliding movement of the device **100** along the longitudinal axis of the control lines **L**.

In the illustrated embodiment, the support structure **20** is defined by a thin one-piece member (the term "member"

as used herein is intended to encompass one-piece and/or multi-piece constructions) have front and rear faces **20a,20b**. The front and rear faces **20a,20b** are shown as planar faces. Each control line receiving location **30a-30h** is connected to or defined as part of the support structure **20** and each location **30a - 30h** is specially conformed and adapted to receive and retain a cable or other control line **L** therein.

In the illustrated embodiment, the support structure **20** is defined from a transparent polymeric material that is tinted (colored) or untinted (clear) to allow objects to be visualized therethrough, although other materials such as metal can be used. The support structure **20** can be rigid or flexible and, in either case, it is resistant to breakage and/or permanent deformation. Suitable polymeric materials from which the support structure can be defined include but are not limited to polyethylene terephthalate (PET), acrylic, polyvinyl chloride (PVC), polystyrene, polycarbonate, and clear styrene-butadiene copolymers (SBC) (K-RESIN), but it is not intended that the present development be limited too any particular material unless specifically recited in a claim. In one example, the polymeric materials are molded or extruded or otherwise

formed to define the support structure 20 as a one-piece construction.

FIG. 4 diagrammatically illustrates use of the device 100 to group, organize and separate multiple cables or other control lines L1 - L8 relative to a an individual control line interface assembly block 110 such as, e.g., an input/output (I/O) connection block for an industrial automation system. The block 110 comprises plurality of control line connectors C1 - C8 to which cables or other control lines L1 - L8 are intended to be respectively connected. The connectors C1 - C8 of the block 110 are arranged in a select pattern. The plurality of control line receiving locations 30a - 30h of the grouping device 100 correspond in number and are arranged relative to each other so as to match or at least correspond to the pattern in which the connectors C1 - C8 are arranged. As such, the device 100 maintains a one-to-one correspondence between the control lines L1 - L8 and the connectors C1 - C8. In other words, the control lines L1 - L8 are held in receiving locations 30a - 30h, respectively, and each receiving location 30a - 30h corresponds to one and only one connector C1 - C8 of the interface module 110 owing to the correspondence between the pattern in which the

connectors C1 - C8 are arranged and the pattern in which the receiving locations 30a - 30h are arranged. As such, a technician can disconnect some or all of the control lines L1 - L8 from their respective mating connectors C1 - C8, and the device 100 holds the control lines L1 - L8 in an arrangement relative to each other that matches the pattern or shape of the connectors C1 - C8 so that each control lines L1 - L8 can be matched and reconnected to the correct connector C1 - C8 based upon the correspondence in location between the connector and one of the receiving locations 30a - 30h. This correspondence between the pattern of the connectors C1 - C8 and the pattern of the receiving locations 30a - 30h provides an obvious one-to-one correspondence between each control line receiving location 30a - 30h and a single connector C1 - C8. Preferably, the receiving locations 30a - 30h are arranged in a shape or pattern that has the same shape or pattern as the shape or pattern in which the connectors C1 - C8 are arranged. As shown, the connectors C1 - C8 are arranged in four linear rows of two linear columns each, and the control line receiving locations 30a - 30h of the device 100 are arranged in a corresponding pattern of four linear rows of two columns each.

FIG. 5A illustrates an embodiment **100-1** of the device **100** wherein a flexible support structure **20** comprises a plurality of control line receiving locations (locations **30d** and **30h** are shown). The support structure **20** includes a peripheral edge **20e**, and the control line receiving locations are each defined by an aperture or opening **32** and a slot **34**. The slot **34** intersects the opening **32** at an inner end and opens through the peripheral edge **20e** at a second end. A cable or other control line is installed into the receiving location **30d**, **30h** by axial insertion of a free end of the control line directly into the opening **32** or by lateral placement of a mid-span portion of the control line into the opening **32** via the slot **34** if disconnection of the cable or other control line is not possible or desirable. The support structure **20** deforms as needed to allow expansion of the slot **34** and opening **32** to accommodate a cable or other control line.

FIGS. 5B, 5C and 5D illustrate an embodiment **100-2** of the device **100** that comprises a support structure **20** having a peripheral edge **20e**. The device **100-2** comprises a plurality of control line receiving locations (locations **30d,30h** are shown). As illustrated, the control line receiving locations **30d,30h** do not open through the

peripheral edge 20e, but they could if desired by forming a slit 33r (shown in broken lines) that connects each location 30d,30h to the peripheral edge 20e. Each control line receiving location 30d,30h is defined by a plurality of flexible flaps 33a,33b,33c,33d arranged adjacent each other and selectively resiliently deflectable outwardly from said support structure 20 to define an opening (see FIG. 5D) that receives a cable or other control line L so that the cable or other control line extends through the support structure 20. As shown, the flexible flaps 33a-33d are arranged in a pie-shaped conformation, with each flexible flap comprising converging lateral sides 33s1,33s2 (see FIG. 5B) that meet adjacent a central region of said control line receiving location 30d,30h.

FIG. 5E illustrates an embodiment 100-3 of the device 100, wherein the support structure 20 is either flexible or rigid. The support structure 20 comprises a peripheral edge 20e and the control line receiving locations such as locations 30d,30h shown, are each defined by an aperture 35 defined through the support structure 20. In the illustrated embodiment, the apertures are isolated from the peripheral edge 20e so as to require axial insertion of a cable or other control line, but the apertures 35

alternatively include slotted portions **35s** that open through the peripheral edge **20e** as shown in phantom lines to allow for lateral or mid-span insertion of a cable or other control line as is often desirable in that disconnection of the cable or other control line is not required to install the device **100-3**.

FIG. 5F illustrates another alternative embodiment **100-4** of the device **100** wherein the support structure **20** comprises an open wire-frame or skeletal framework **37** defined from metal or a molded plastic construction. As shown, the framework **37** comprises a one-piece molded polymeric construction defined from any suitable material such as (but not limited to) polyethylene (PE), polypropylene (PP), acrylonitrile-butadiene-styrene (ABS), and polyvinyl chloride (PVC). The control line receiving locations (only locations **30c,30d** are shown) are defined by first and second fingers **38a,38b** arranged to define a recess **38c** therebetween that receives and retains a cable or other control line **L** as shown in phantom lines. As shown, the distal ends of the fingers **38a,38b** are spaced from each other to define an open mouth **38d** that leads to the recess **38c** to allow for lateral insertion of a mid-span portion of the cable or other control line **L** into the

recess 38c. The fingers 38a,38b are resiliently deflectable away from each other to allow for insertion of a cable or other control line L into the recess 38c, where the fingers 38a,38b then resiliently grip the control line L owing to their natural resiliency. The open framework structure results in the definition of multiple large viewing locations or windows W1,W2 between control line receiving locations.

The support structure 20 of the device is preferably transparent or comprises an open framework so that the device 100 does not obstruct viewing of the control line interface assembly or block 10,110 in connection with which the device 100 is being used, even though the device 100 holds the cables in a pattern that corresponds to the pattern in which the connectors C1-C8 of the interface assembly or block 10,110 are arranged and despite the fact that the device 100 covers or overlies the interface assembly or block 10,110 when in use. In particular, it is important that a technician or other person be able to view the indicia I and visual indicators such as the light emitting diodes LED on the control line interface devices 10,110 even when the device 100 is installed.

As shown in FIG. 6A, the device 100 is preferably movably connected to a fixed location such as, e.g., the control line interface block 110. As shown in FIG. 6A, a chain or other tether 60 extends between and interconnects the control line interface block 110 and the device 100. Aside from preventing loss or damage to the device 100, the tether 60 helps to orient the device 100 because it preferably has a length that allows for only one operative orientation of the device relative to the block 110.

FIG. 6B illustrates an alternative arrangement wherein the tether 60' is defined as a one-piece construction with the device 100. As shown, the tether 60' is defined as a strap-like extension of the device that is connected to the block 110 (e.g., behind the block 110) via fasteners 62. Defining the tether as a strap-like member 60' inhibits accidental twisting of the device 100 relative to the block 110.

FIG. 7 is similar to FIG. 2B and shows a control line interface block 110 such as an industrial automation input/output connection block that comprises plurality of control line connectors C1 - C4 to which data cables or other control lines L1 - L4 are respectively connected. The block 110 is connected to a base structure or bracket S

by fasteners or the like (not shown). The bracket **S** comprises a C-shaped cross-section (FIG. 2B) defined by a base wall **S1** and first and second side walls **S2,S3** so that the support bracket **S** defines an open recess **S4** that houses the interface block **110**. A device **100** for grouping, organizing and separating multiple cables and other control lines formed in accordance with the present development is operatively installed and is movably connected to the bracket **S** via tether **60**. The cables or other control lines **L1 - L4** are releasably received and retained in receiving locations **30a - 30d**. The transparency and/or open framework structure of the device **100** ensures that the device **100** does not obstruct visualization of the block **110** (and indicia **I** and lights such as LED's thereon) by a technician or other person. Each connector **C1 - C4** of the interface device **110** defines a connection axis **CA1 - CA4** along which an associated control line connector **CL1 - CL4** mates therewith. It can be seen that the device **100** holds the control lines **L1 - L4** in a position so that the control line connectors **CL1 - CL4** are aligned with the connection axes of the connectors **C1 - C4**, respectively, so that it is readily apparent which control line connector **CL1 - CL4** is to be mated to a particular connector **C1 - C4**.

Referring again to FIG. 6A, the device 100 optionally includes printed, embossed, or other indicia N1 that uniquely identifies each control line receiving location 30a - 30h. The device 100 also optionally includes indicia N2 that provides brand or other information.

Those of ordinary skill in the art will recognize that a device 100 formed in accordance with the present development can be scaled or re-sized as required for any particular application so as to include more or less control line receiving locations 30 in any desired size/shape. FIG. 8 illustrates a device 100-5 for grouping, organizing and separating multiple cables or other control lines (a control line L1 is shown) formed in accordance with another alternative embodiment as installed for use in association with a rack-mounted control line interface device such as an ethernet switch 210. The interface device 210 is supported on a rack R or like mounting structure and includes a plurality of connectors C to which control lines such as the control line L1 are adapted to be connected. The device 100-5 includes a corresponding number of control line receiving locations 30 that are arranged in a pattern that corresponds exactly to the pattern in which the connectors C are arranged on the

device 210. The device 100-5 is preferably movably connected to the rack R and thus includes a chain, strap or other tether 60 that extends between and interconnects the rack R and the device 100-5. Aside from preventing loss or damage to the device 100-5, the tether 60 helps to orient the device 100-5 because it preferably has a length that allows for only one operative orientation of the device relative to the rack-mounted device 210. As shown, the device 100-5 includes two horizontal rows of multiple control line receiving locations 30, and each row includes a different number of control line receiving locations 30.

FIGS. 9A and 9B illustrates a support bracket structure SB for a control line interface device 110 such as a modular input/output electrical device or the like. The device 110 includes a plurality of connectors C1 - C4 to which a corresponding plurality of control lines L (e.g., electrical cables, hydraulic hoses, pneumatic hoses, etc.) are adapted to be connected.

The support bracket structure SB comprises a C-shaped cross-section defined by a base wall SB1 and first and second side walls SB2, SB3 so that the support bracket SB defines an open recess SB4 that houses the control line interface block 110.

The support bracket structure **SB** further comprises a plurality of control line receiving locations **330a - 330d** (FIG. 9B) connected thereto or defined as a part of one of the walls **SB1,SB2,SB3**. These control line receiving locations **330a - 330d** are adapted to receive and retain electrical cables and other control lines **L** so as to hold same in a fixed position relative to the bracket **SB** and the control line interface device **110** mounted to the bracket.

In one embodiment, the locations **330a - 330d** are defined as a one-piece molded plastic or metallic construction with the wall **SB2** as shown. Each control line receiving location **330a - 330d** is adapted to receive and releasably retain an electrical cable or other control line **L** (see control lines **L1,L2** shown in FIG. 9B) in a fixed position relative to the bracket **SB** so as to facilitate correct mating of each control line **L** to a particular connector **C1 - C4**.

As shown in FIG. 9B, the control line receiving locations **330a - 330d** are each defined by first and second fingers **338a,338b** arranged to define a recess **338c** therebetween that receives and retains a cable or other control line **L** such as control lines **L1,L2** shown in phantom lines. As shown, the distal ends of the fingers **338a,338b**

are spaced from each other to define an open mouth 338d that leads to the recess 338c to allow for lateral insertion of a mid-span portion of the cable or other control line L into the recess 338c. The fingers 338a,338b are optionally resiliently deflectable away from each other to allow for insertion of a cable or other control line L into the recess 338c, where the fingers 338a,338b then resiliently grip the control line L owing to their natural resiliency. In one embodiment, the bracket SB, including the control line receiving locations 330a - 330d is defined as a one-piece molded polymeric or metallic construction. The support bracket SB is intended to be used alone or in combination with a device 100 formed in accordance with the present development, e.g., in place of the bracket S shown in FIG. 7.

It will be readily apparent to those of ordinary skill in the art that use of a device 100 to organize, separate and retain multiple control lines in accordance with the present development saves time and, consequently, reduces costs associated with operations when the control lines must be disconnected from connectors of a control line interface block 10,110,210 and later reconnected to the same connectors or corresponding connectors of a

replacement interface device. The need for individual cable labeling is eliminated and the likelihood of improper connections is reduced.

Modifications and alterations will occur to those of ordinary skill in the art. It is intended that the following claims be construed literally and/or according to the doctrine of equivalents so as to encompass all such modifications and alterations to the fullest extent available under the law.